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ABSTRACT

This paper reports a preliminary study on the development of a linear-programing- type model to stimulate a constrained Federal program of educational support to the States. This model determines the distribution of fixed amount funds according to some measure of effectiveness. Federal involvement so far has been in the form of Federal aid that is temporary, specific, and often used for remedial purposes or appropriated for emergency situations. A Federal support program, on the other hand, underwrites a Federal Government share in State and local financing. It is directed to general school operation, attacks fundamental problems of broad financial needs, and involves longrange commitment on the part of the Federal Government. The model proposed herein could be helpful in making this transition from Federal aid to Federal support. (Author/JF)

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A PROPOSED SCHEME FOR FEDERAL SUPPORT FOR EDUCATION

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A PROPOSED SCHEME FOR FEDERAL SUPPORT FOR EDUCATION

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PREFACE

At some time in the near future, the expanding role of the Federal Government in education might result in some sort of basic, general Federal support for education. Critical to any such educational support plan will be the development of a rational and systematic method for distributing Federal resources to the states. The use of a linear-programming model to simulate a constrained Federal program of educational support to the states is an ideal method for determining strategies for such resource allocation.

The use of simulation techniques will require that indices or qualitative measures of the needs, abilities, and effort of each of the states be developed, so that these factors can be considered objectively. One method of representing these measures is by the application of a correction factor to the present program of educational support. This Document describes the development of a linear-programming-type model for the distribution of Federal funds for education to the states, and also discusses one of the methods which might be used in the determination or derivation of the correction factor to be applied to the states educational expenditure for each state in the system.

It must be emphasized that the model proposed in this study is not an econometric model, and its purpose is not to derive the optimal investment or expenditure of Federal funds in education but rather to determine the distribution of a fixed amount of funds according to some agreed-upon measure of effectiveness. The economic or other values of

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the federal investment in education will not be discussed. And finally, the study reported here should be viewed as a preliminary or prototype study only, since a great deal of information, which might result in the reformulation of the model itself, will be gained by actually applying the model in an actual situation.

I. A BRIEF HISTORY OF FEDERAL AID TO EDUCATION

FEDERAL EDUCATIONAL ACTIVITIES: PAST AND PRESENT

A recent article in Fortune magazine describing what President Johnson has frequently referred to as "creative federalism" states that creative federalism is premised on the belief that our society is "exceedingly lively, increasing its rate of innovation and expanding its range of opportunity." (1) The article continues:

> In the long American dialogue over state's rights, it has been tacitly assumed that the total amount of power was constant and therefore, any increase in federal power diminished the power of the states and "the people." Creative federalism starts from the contrary belief that total power--private and public, individual and organizational--is expanding very rapidly. As the range of conscious choice widens, it is possible to think of vast increases of federal government power that do not encroach upon or diminish any other power. Simultaneously, the power of states and local government will increase.

This line of reasoning has formed a rationale for the expanding federal involvement in many areas that were formerly the province of state and local governments. However, the expansion of power by the state governments has not been equal to that by the Federal Government; Federal expansion of influence or power has increased at a greater rate. Traditionally, federal involvement in state matters has been considered justifiable in areas where (1) there is a shared responsibility for carrying out an important public purpose, (2) all partners (state, local, and federal) have a common interest and benefit, and (3) no one agency could accomplish the task as well without the cooperation of the others.

Federal involvement in education has generally been established in response to the following needs or situations:

1. Provision of education for those individuals for whom the federal government accepts responsibility. Included in this category are:

- o American Indians (Federal aid is provided both to schools operated by the Bureau of Indian Affairs (BIA) and to school districts in areas in which Indians reside, under the Johnson-O'Malley Act)
- o Residents of federal reservations (PL874)
- o Dependents of U.S. employees stationed overseas
- o War veterans (Federal aid is provided through VA program grants)
- o Cuban refugees (Federal aid is provided through grants to Dade county)
- o Trainees selected for vocational education by the Labor Department under the Manpower Development Training Act (MDTA)

2. To broaden the scope or improve the quality of school programs that have aspects which are directly supportive of Federal noneducational activities such as national defense or elimination of unemployment. Included in this category are:

- o ROTC and related programs at colleges and universities
- o Vocational education programs
- o Programs designed to improve instruction in science, mathematics, and foreign languages
- o Programs designed to increase the supply of teachers in all fields (e.g., student loans)
- o School lunch programs
- o Expansion of the scope of the National Defense Education Act of 1958

3. To compensate for deficiencies in the school tax base where there is concern about the adequacy of the tax base to support education: Programs in this category include:

- o Shared earnings from Federal tax-exempt lands (the Taylor Grazing Act and similar acts)
- o Payments in lieu of taxes under TVA and similar programs
- o Payments to local school districts under Sec. 3 of PL874*
- o Payments for school construction under subsection 5(a) (1) and (2) of PL815*

*See Appendix.

These situations account, in part, for the involvement of the Federal Government in education. Moreover, because of the mobility of society, the current emphasis on equality of educational opportunity, and the skills and knowledge required for the defense of the country the Federal Government will have an even greater role for education in the future. At this point it might be helpful to briefly describe how the Federal role in education has changed and expanded over the last 200 years, in order to indicate the areas in which future expansion of Federal involvement may be expected to take place.

The development of the Federal role in education can be traced, historically, to pre-Federal origins and through the early days of the new nation. The origin of the principle that is still very firmly held, namely, that the development and financing of education is a local and state function, can also be traced to this early period in American history. An examination of the milestones in Federal education since 1862 suggests a general Federal policy geared to the promotion and support of those special services, such as agriculture and mechanical arts and sciences, which the Federal Government felt could be most effectively and economically provided by educational institutions. Nevertheless, the involvement of the Federal Government in education has increased steadily from the colonial period until the present, and there are now over 250 separate U.S. Government educational operations or programs being carried on by 12 departments and 26 independent agencies. cies.(2)

The myriad of Federal educational activities can be categoriezed into seven areas, which are described briefly below.

1. Aid for Federally Operated Educational Programs. Federal funda are used to finance the educational activities of the armed forces, the training of Federal employees, and education in special Federal jurisdictions.

2. General Federal Aids to Education. The Federal Government has provided general assistance to education in the form of land for schools. For example, the early land grants of 1785 and 1787 endowed schools with public lands; and as a condition for admittance of Ohio to the Union, the Ohio Enabling Act of 1802 specified that public lands be set aside for schools.

3. Special Federal Aids to Education. From the Morrill Act of 1862 to the National Defense Education Act (NDEA) of 1958, there have been many special programs of Federal aid to education. Such programs are used to promote some national goal or policy: The Morrill Act of 1862 set up the national land-grant system; the Smith-Hughes Vocational Act 1917 set up vocational education programs in agriculture, trades and industries, and home economics, and in the training ofteachers in these fields; the NDEA was an umbrella type of Federal program enacted in 1958 to strengthen critical areas in education such as science, mathematics, foreign language, counseling, testing, guidance, graduate fellowships, research and experimentation in modern teaching tools (TV, films, etc.), and improvement in statistical and information services.

4. Federal Education Aid to Special Groups. An example of Federal aid to special groups, the Government provides financial aid to ex-servicemen for use in furthering their education. After World War I, in 1918, the Veteran's Vocational Rehabilitation Act was passed. During World War II, Federal funds were provided through Servicemen's Readjustment Act of 1944. Veterans of the Korean and Vietnam Wars have also received Federal aid to support their educational expenditures.

5. Federal Aid to Educational Programs of Public Service. In 1950 the National Science Foundation (NSF) was established as the focal Government agency for science; the NSF provides direct support for education in fields that are in the public interest. An example of indirect aid for public-service purposes is the school lunch program of 1946. Indirect Federal aid would also include the purchases of goods and services connected with education that are considered vital or necessary for national defense.

6. Federal Aid to Education in Lieu of Taxes. Aid to education in the form of partial tax payments recognizes specially Federally created situations in which there is redress only to the Federal Government. Public Laws 817 and 874 in 1950 gave financial help to schools in communities where large Federal projects such as airbases, military installations, etc., were suddenly established. Essentially, the Government gives payment in lieu of the property tax to the school districts in Federally impacted areas.

7. Federal Aid to Promote Educational Cooperation With Other Countries. The Convention for the Promotion of Inter-American Cultural Relations at Buenos Aires in 1936 provided for an exchange of graduate students between the signatory states and served as a pilot program for the Fulbright Act of 1946, which continues to function as a major vehicle for international educational exchange programs.

FUTURE PROPOSALS CONCERNING THE FEDERAL GOVERNMENT AND EDUCATION

In the future, we may expect still further involvement of the federal government in education. Among the proposals that might be anticipated are the following:

1. Proposals for interstate equalization and general support of education, to ensure quality of educational opportunity throughout the country,
2. Proposals for income-tax relief based upon taxpayers' local taxes for education and other educational expenses,
3. Proposals for "purely fiscal" block transfers of federal tax revenues back to states for the support of education.

In regard to Item 3 above, it is interesting to compare percentages of school support provided by the Federal, state, and local governements with the percentages of the total tax take of each. These percentages are shown in Table 1 for 1957-1958.(4)

Table 1

PERCENTAGES OF TOTAL TAX TAKE AND SCHOOL SUPPORT

Government	Total Tax Take (%)	School Support (%)
	1957-1958	
Federal	69	4
State	15	40
Local	16	56

Table 2 shows the percentages of Federal, state and local support as a function of time. Notice the gradual increase in the percentage of Federal revenue, and the gradual decline in the percentage of local revenue. Also, notice the increase in the percentage of state revenue devoted to education.

Table 2

PUBLIC ELEMENTARY AND SECONDARY SCHOOLS--
REVENUE, BY SOURCE OF FUNDS[a]

School Year	Total revenue for public schools	Federal		State		Intermediate and local sources[2]	
		Amount	Percent	Amount	Percent	Amount	Percent
1940	2,261	40	1.8	684	30.3	1,536	68.0
1942	2,417	34	1.4	760	31.5	1,622	67.1
1944	2,604	36	1.4	859	33.0	1,709	65.6
1946	3,060	41	1.4	1,062	34.7	1,956	63.8
1948	4,312	120	2.8	1,676	38.9	2,515	58.3
1950	5,437	156	2.9	2,166	39.8	3,116	57.3
1952	6,424	228	3.5	2,479	38.6	3,718	57.8
1954	7,867	355	4.5	2,944	37.4	4,568	58.1
1956	9,687	441	4.6	3,829	39.5	5,416	55.9
1958	12,182	487	4.0	4,800	39.4	6,895	56.6
1960	14,747	652	4.4	5,768	39.1	8,327	56.5
1962	17,528	761	4.3	6,789	38.7	9,978	56.9
1964	20,544	897	4.4	8,078	39.3	11,569	56.3
1966 (prel.)	25,481	2,016	7.9	9,887	38.8	13,578	53.3

Source: Dept. of Health, Education, and Welfare, Office of Education; biennial report, Statistics of State School Systems, 1963-64 and Preliminary Statistics of State School Systems, 1965-66.

[a] In millions of dollars, except percent. Prior to 1960, excludes Alaska and Hawaii. See also Historical Statistics, Colonial Times in 1967, series H 246-251.

[b] Includes receipts from gifts and fror tuition and transportation fees paid by patrons.

Wealthy states, such as California, New York, and Massachusetts, can cite these figures as an argument for supporting legislation for the block transfer of federal tax revenues back to the states. The principle of taxing wealthy states to support economic and social development for the less wealthy areas of the country is well established in Congressional legislation. It seems unlikely that the proposal for transferring Federal tax revenues back to the states would be pursued by Congress unless, of course, an extremely conservative administration came to power.

Income-tax relief based upon amounts of local taxes paid for education and educational expenses would provide tangible incentives for supporting education. Unfortunately, the inequitable tax structure in the country is only responsive to highly organized lobbies and special-interest groups. Since the Federal Government is always in need of money and the tax structure is such that it favors these special-interest groups and is essentially inflexible, the proposal would not have a great chance of being passed. In short, tax laws are extremely difficult to change, and only by courageous leadership on the part of the Executive branch of the Government, with the cooperation of the Congress, can tax laws be changed or altered.

Thus, of the three proposals, it seems that the first--Federal aid for interstate equalization and support of education--would have the highest probability of being acted upon by Congress.

TYPES OF FEDERAL GRANT-IN-AID PLANS

It would be appropriate at this point to review the types of grand-in-aid plans that the Federal Government can employ in any program of support to the states:

1. Fixed Per Capita Grants-In-Aid: a fixed amount is given to the state by the Federal Government for each average day of attendance (ADA), the index of load
2. Nonmatching Equalization: funds are distributed in accordance with fiscal capacity and load of the state, regardless of the amount of Federal funds used

3. Limited Matching: funds are distributed in accordance with the amount contributed to the educational system by the state, but the total amount of state funds to be matched by the Federal Government is limited
4. Unlimited Matching: same as Limited Matching except that no restriction is placed upon the amount of Federal funds to be matched
5. Fixed-Ratio Matching: funds raised by all political subdivisions or states are matched according to the same basic ratio irrespective of the relative fiscal capacities of the subdivisions or states
6. Equalized Matching: matching ratios are applied to funds contributed to the project by political subdivisions or states, which vary in accordance with the fiscal capacity and load of the subdivision or state

NEED FOR A METHOD TO DETERMINE RESOURCE ALLOCATION

If the proposals for Federal funds to be used in interstate equalization and general support are accepted, the Federal Government will need to develop models, methods or formulas for distributing funds to the states. Some work has already been completed on possible schemes for a Federally financed educational support program.(10) One limiting characteristic of most of this preliminary work is its apparent neglect of the political and economic constraints which will be placed upon any future Federal-state support program. Political constraints might involve the minimum or maximum amount of Federal aid to be granted to any one state, or the percentage relationships established among Federal, state, and local funds in the education programs of each state. Economic constraints might be set, for example, by the budget available to finance the entire educational support program.

The remainder of this Document describes a mathematical programming model that would provide a rational and systematic method for calculating the amount of Federal aid to be distributed to each state. This prototype model takes into consideration the ability of the state

to support its educational program, and the constraints (political, social, and economic) that might be placed upon the resources of the Federal Government and the Federal/state interrelationships within the system.

The prototype model includes a correction factor that has been derived to adjust each state's educational expenditure in accordance with its available resources for educational support.

II. A MATHEMATICAL MODEL FOR FEDERAL AID TO EDUCATION

GENERAL DESIGN CRITERION

As previously outlined, one of the major arguments for Federal aid to education is based upon the national concern for strengthening the educational program in the less wealthy areas of the country. It follows, therefore, that any plan for federal aid to education should provide for some degree of equalization of school support. There is also a general conviction on the part of educational planners that the states should continue to exert reasonable local effort to support education and that any Federal aid should not result in a corresponding reduction in the state level of educational support. Thus it is important that any model of Federal educational support be sensitive to relative increases or decreases in the level of each state's effort to support its own educational programs. To meet this design criterion, sensitive and rational indices of needs, ability, and effort to provide support had to be developed.

Congressional interest in indices to measure efforts to support education has been reflected in reports to various committees of Congress.(4) Many proposals have been made before Congress requesting Federal support for education, cindlugin the School Construction Act of 1956, the School Support Act of 1959 (Murray-Metcalf), and the School Systems Act of 1961 (Morse). All of these proposals require that the states continue making a "satisfactory effort" to support their public schools, and in each case a penalty factor was to be applied if the state fell below a certain minimum level of support.

In 1926, state financial effort to support public schools was defined as "the percentage of the state's economic power which it annually spends for education."(5) This means that the percentage of the total state budget which is expended for education can be used as an index of effort. Benson,(6) in his textbook on school finance, charted the relationship between expenditure per pupil and income per capita for the state as an index of effort. He expressed this effort index by the equation

$$\text{Effort} = \frac{\text{Expenditure per pupil}}{\text{Fiscal ability (income per capita)}}$$

A question often asked is, Should each state be expected to devote the same portion of fiscal ability to public education purposes? According to Mort[7] (who is considered to be an expert in school finance):

> The use of the same percentage for all states of the yield of these selective taxes for the support of any one of the social functions of government, such as education, may not be entirely justified.

It may not be reasonable to equate the percentage of the total budget expended for education with effort because of the widely differing needs of the states. In some states a great part of the total budget is devoted to welfare and highways; for these states it would be incorrect to measure effort by the <u>percentage</u> of the budget allocated to education.

Conceptually, according to Alkin, effort has continued to be considered as a quotient of educational expenditures and somemmeasure of fiscal ability of states, where these measures may be modified slightly by the assignment of various weightings.

Several recent research reports concerned with educational finance are germane to this discussion and lead to a reexamination of traditional effort formulation. James[8] (1963) recognized the importance of considering various governmental and situational impediments to the utilization of local fiscal ability. Lindman[9] (1964) examined the relationship between total populations and numbers of public-school children and demonstrated wide differences in the ratio for different localities. Lindman's thesis was that it is nec necessary to recognize demographic composition and characteristics of a community in order to make assumptions as to which portion of the public-sector fiscal ability might be allocated for educational purposes.

In addition to the indices of need, ability, and effort, other factors were considered in the model. The competition for the tax dollar in many states has left educational support at an extreme disadvantage. The long-term benefits of educational expenditures have been severely overshadowed by the immediate results to be gained from "short-term" items in the state budgets. These items--e.g., welfare programs, highways, law enforcement--are growing at astounding rates in many states and cities. As a result, the taxpayers in these states and cities have been asked to either support a larger tax burden or establish priorities as to what is needed by the community or state. The net result of this competition for funds has been that the taxpayer has favored the more local, tangible, and immediately necessary services of the state and city governments over the intangible, less local, long-range service of education. The current difficulties of getting bond issues and tax overrides passed in many states attest to this contention.

In short, previous research on the problems of determining the effort of the states and their ability to support education was limited in scope, since only one or two of the variables that might be used (median family income, percentage of the state budget devoted to education, etc.) were studied. As a result, little agreement could be found among educators for assessing the ability of the state to support education. A prediction model with a dependent variable of state expenditure for education and a large set of independent variables, such as median income, percent of the budget devoted to areas other than education, and percent of the population in state-supported schools, would be therefore a very useful and rational technique to employ in this analysis. The model proposed in this Document also incorporates a correction factor to reflect relative competition for the tax base between educational and noneducational expenses. Using a stepwise, multiple-linear-regression model, it is possible not only to develop a prediction equation but also to determine those variables that explain the greatest variance. If a single variable could be identified as having the greatest predictive power, state expenditures for education could be plotted as a quadratic or higher-order function of this variable, and highly accurate prediction formula could then be derived.

DERIVATION OF THE CORRECTION FACTOR

The amount of funds a state has available to support its educational program would have to be adjusted before inclusion in the model to account for states that exert a greater effort to support education than their ability would indicate, for states that exert an effort corresponding to their ability, and finally for states that do not exert an effort commensurate with their ability. The correction factor recognizes, by means of financial incentives, those states whose efforts exceed their ability and penalizes those states whose effort is less than their fiscal ability. Essentially, the correction factor is multiplied by each state's total expenditure for education to determine its adjusted expenditure relative to the effort of the rest of the states. If the correction factor equals 1, the state is making effort equal to its ability; it is greater than 1, the state is making less effort than its ability would warrant.

To determine the effort exerted by state to support education a multiple linear-regression model was developed of the form

$$y = b_1x_1 + b_2x_2 + \ldots + b_nx_n$$

where

y = the variable to be predicted (dependent variable) e.g., the total state expenditure for education

x_j = the variables that would determine the level of support for education (independent variables)

b_j = the weights to be associated with each of independent variables in the model

j = the number assigned to the variable - 1, . . . n

From the above regression model the correction factor for each state, i, can be derived by means of the following formula:

$$C_i = \frac{y_p}{y_i}$$

where

y_p = the predicted total expenditure for education for the state, i, from the regression model

y_i = the actual total expenditure for education

C_i = the correction factor to be applied to the total state expenditure (if the ratio of predicted to actual expenditure is 1, then the state is making normal effort; if the ratio is less than 1, the state is making greater effort; if greater than 1, the state is making less effort than it could).

The regression model can be constructed using as independent variables the state's total population, the total weighted school population, the median income, the percentage of the state budget allocated for education, assessed valuation per ADA, the total state budget, the number of students at each of the three levels of education, etc. The dependent variable is the state's total expenditure for education. The ratio of the predicted expenditure to the actual expenditure is the correction factor. Each state's correction factor would thus tend to normalize the state's educational effort (expressed in expenditure) in relation to the educational efforts of the other states in the system.

The above list of independent variables is by no means complete, and a great deal of empirical research would be necessary to develop a satisfactory predictive model. The methodology, however, for deriving a correction factor seems reasonable. This derivation would make an important contribution to the effectiveness of the model and is at least worthy of further investigation.

CONSIDERATIONS NECESSARY FOR GENERAL STATE EDUCATIONAL SUPPORT

The weighted ADA is used as an independent variable so that federal support can be considered for a total educational program--elementary, secondary and higher. Each of the levels can also be considered separately, but separate models for allocation of Federal resources to these levels would have to be developed.

The proposed model will allocate Federal aid to each state to furnish partial support for its entire educational system. This requires that a weighted student-load be developed. The weighted student is derived for each state by determining the cost per student for each level of education and then dividing each of these costs by the lowest cost per student. For example, suppose in a given state the cost per student for each of the levels of education were as follows:

Level	Cost/Student	Weight
Elementary	200	1
Secondary	400	2
Higher	800	4

For this particular state the number of elementary students plus twice the number of secondary students plus four times the number of higher-education students in the state-supported schools in the state will yield the total weighted ADA.

It might also be possible to utilize national expenditure norms to determine the weighting factors for students at each level of education. It may, for some cases, be desirable to allow the weighting factor to be a variable, or to keep each weighting factor separate so that a cost-sensitivity analysis can be performed on the weights by parameterization of the weighting factor. Such an analysis might be useful in determining Federal allocation of resources strategies under various population trends. For example, if college enrollments are expected to increase and elementary enrollments are on the decline, it might be a preferable strategy to place more Federal resources at the college level. Another strategy might be to place as much of the resources as possible at the elementary level--essentially to make the initial investment and do a good job at the early stages of a student's development.

In addition, many states are in the process of developing or have developed junior college systems; therefore a weighting factor for junior college students should also be derived. In either case, the term ADA will refer to the total weighted ADA throughout this paper.

DEVELOPMENT OF THE MODEL

As previously mentioned, the proposed model for a Federal-state educational support program will be of a linear-programming type. The constraint set of the model will consist of the equations given below.

The basic equation which calculates the amount of Federal aid to be given to any state, i, is

$$FF_i + C_i A_i \geq (FD_i)\ (ADA_i) \qquad (1)$$

where

FF_i = the total amount of Federal aid to state i, millions of dollars

A_i = the total amount of funds used by the state to support education, millions of dollars

C_i = the correction factor, which represents the ratio of the predicted to actual state expenditures for education (the predicted expenditure for education is determined by means of a multiple linear-regression equation)

FD_i = the minimum level of expenditure or support per weighted ADA which would be guaranteed by the Federal government to each state, i

ADA_i = the weighted ADA (full-time equivalents) in state i

It should be noted that A_i includes both local funds raised via the property tax and state funds, i.e.,

$$A_i = S_i + L_i$$

S_i = state funds allocated by the legislature to support education, millions of dollars

L_i = local funds used to support education, millions of dollars

The amount of Federal funds to be distributed to each state will be constrained by imposing a maximum and minimum percentage of the

<u>adjusted</u> state funds on this variable:

$$FF_i \leq \beta_1 C_i A_i \tag{2}$$

$$FF_i \geq \beta_2 C_i A_i \tag{3}$$

where

β_1 = the maximum percentage of Federal funds to the adjusted state funds

β_2 = the minimum percentage of Federal funds to the adjusted state funds

The total amount of Federal funds used in the entire system will be constrained by imposing a maximum and minimum percentage relationship on total Federal funds. This is represented mathematically in the model as:

$$\Sigma FF_i \leq \delta_1 \Sigma C_i A_i \tag{4}$$

$$\Sigma FF_i \geq \delta_2 \Sigma C_i A_i \tag{5}$$

where

δ_1 = the maximum percentage of Federal funds to state funds for the entire program

δ_2 = the minimum percentage of Federal funds to state funds for the entire program

An educational constraint representing the minimum and maximum guaranteed level of expenditure for each state i per ADA, which can be ealculated by taking some specified percentage of the corrected state expenditure per weighted ADA in each state i, can also be imposed on the system by the inclusion into the model of equations of the following type:

$$FD_i \leq \sigma_1 C_i A_i / ADA_i \tag{6}$$

$$FD_i \geq \sigma_2 C_i A_i / ADA_i \tag{7}$$

where

σ_1 = the maximum percentage of the adjusted state expenditure per ADA that the Federal Government would guarantee in each state i

σ_2 = the minimum percentage of the adjusted state expenditure per ADA that the Federal Government would guarantee in each state i

In addition, a specified lower- and upper-bound constraint can be placed upon this variable in the model:

$$FD_i \geq \lambda_1 \tag{8}$$

$$FD_i \leq \lambda_2 \tag{9}$$

where

λ_1 = the maximum guaranteed level of support per ADA for any state i

λ_2 = the minimum guaranteed level of support per ADA for any state i

The maximum and minimum guaranteed Federal expenditure per ADA (λ_2 and λ_1) can probably be determined empirically by calculating the present average level of expenditure for all the states in the system and taking some percentage of this amount.

Finally, the total amount of Federal funds which would be available to such a system can be constrained and represented in the model by means of the following equation:

$$\Sigma FF_i = T$$

The model is now a closed or bounded system, whereby a fixed amount of Federal funds is distributed to each state in accordance

with its need (defined by the correction factor) and subject to constraints such as the maximum and minimum percentage relationships of Federal to state funds (to both individual states and all the states) and the minimum amount of Federal aid to be allotted for each state.

FUTURE ADDITIONS TO THE CONSTRAINT SET

With additional time and effort, the above set of equations could be expanded to include other Federal/state interrelationships and additional lower-bound constraints which would make the model more effective. The intent of the above discussion was merely to outline the basic framework of a prototype model. Gradually, as more information concerning educational need, state ability to support education, etc., becomes available, it can easily be incorporated into the model. A great amount of empirical research, therefore, is still needed in educational finance; one important contribution that can be made by a model such as we have proposed is the pointing out of areas for future research. Possibly some index or method for calculating the minimum educational "need" for which the Federal government assumes responsibility could be derived. When such a method becomes available, then an equation of the following form can be included in the model:

$$FF_i \geq N_i$$

where

FF_i = the total Federal aid to state i

N_i = the financial need of state i for which the Federal government assumes responsibility, millions of dollars (N_i might simply be some percentage of the current adjusted state expenditure).

The minimum need (N_i) of each state i for which the Federal Government accepts responsibility might be determined by either assuming some arbitrary, but reasonable, percentage of the adjusted state expenditure for education or by utilizing PPBS to determine the costs of various programs for which the government will accept responsibility.

In addition a future modification of the Federal Educational Support Model might address itself to the problem of determining a more effective method or unit to a particular state upon which to base the amount of educational support given.

The allocation of state resources on an ADA (average daily attendance) is the most widely used method for basing educational support due to its simplicity and convenience. For example the state might allocate to district X, $125/ADA and to district Y, $250/ADA. Unfortunately basing the state allocation formula on an aid per ADA basis tends to disguise exactly what the state is purchasing in the way of educational programs at the district level. It might be more advantageous for the state to break down this overall ADA expenditure amount by expenditures necessary to support different facets of a school district's educational program. This might entail breakdowns covering areas such as pupil transportation, teacher salaries, compensatory education programs, vocational programs, etc., for which the state would assume partial or full financial responsibility. The state would then allocate its financial resources according to a multitude of criteria instead of just an ADA basis. This type of strategy would more closely reflect the actual financial need of a school district and give the state a clearer picture and insight upon which to determine state allocation of funds.

This same principle of breakdown of educational costs by program, can also be used to determine the financial needs of each state for basic educational programs and present the Federal Government with a better assessment of the actual financial needs for each state.

POSSIBLE OBJECTIVE FUNCTIONS OF A FEDERAL EDUCATIONAL-SUPPORT MODEL

The objective functions that can be explored by educational planners using the proposed Federal educational-support model would include:

1. Minimization of Federal funds used in the system
2. Maximization of the guaranteed support level for each state
3. Minimization of the spread in expenditures per ADA

4. Maximization or minimization of a utility function which would be used to represent the effectiveness of the system, such as a linear or weighted linear combination of one or more of the variables in the system

USES OF THE MODEL

Selected variables in the educational-support model can also be parameterized to yield alternate optimal solutions. These variables might include

1. The minimum guaranteed support level
2. The amount of Federal funds available
3. Some of the percentage relationships in the model

It might also be possible to use the correction factor as a variable in the system, with the lower bound being the value obtained via the ratio of predicted to actual expenditures. Using the correction factor as a variable might lead to very interesting solutions whereby, depending upon the nature of the objective function, some of the less wealthy states might receive substantial increases in funding.

In summary, the proposed model can be used to point out inconsistent constraints, to devise more effective or more politically stable objective functions, to explore cost sensitivities of the various parameters, and to indicate fruitful areas for future educational research in school finance.

The use of a linear-programming model for allocation of Federal educational funds to the states can provide a systematic method for distribution of resources according to some agreed-upon measure of effectiveness. Most of the data needed by the model and the regression equations are available from state departments of education and the U.S. Office of Education. Some arbitrary but reasonable upper and lower bounds will have to be assumed in order for the model to provide a solution, and some of the proposed percentage relationships would have to be inferred from historical precedent and the "mood" of the legislature. A number of these "arbitrary" percentages could be parameterized in order to determine the sensitivity of the model to them.

If the model is extremely sensitive, then further investigation could be required; it might be more beneficial to present the alternate preferred solutions corresponding to the parameterization of certain selected variables to the legislature for discussions and compromise.

In conclusion, solving the model using various objective functions. the use of postoptimal sensitivity analysis (dual solution, reduced costs, and ranging analysis), and parameterization of selected variables in Federal support programs would be of value to both educational planners, who could use the information to provide impetus for further areas of research or reformulations of the model, and to the legislature, which could use the information supplied by the model as a starting point for discussions, arbitration, and compromise.

III. CONCLUDING REMARKS

The role of the Federal government in education is changing. Most of the Federal involvement in education up to the present has been in the form of what might be characterized as "Federal aid to education." Federal aid to education has the following characteristics:

1. It is intended to stimulate educational activity temporarily rather than to underwrite it for a long period of time
2. It is usually intended to meet a specific need rather than to strengthen the total educational program
3. It tends to be used for remedial purposes rather than fundamental purposes
4. It tends to deal with emergency situations rather than long-range problems
5. It requires relatively small Federal appropriations, compared with overall educational needs

The future role of the Federal Government in education, and the role to which the proposed model addresses itself, is the type of funding that might be termed "Federal support for education." Federal support for education embodies the following characteristics:

1. It is an underwriting by the Federal Government of a share in local and state financing of education
2. It is directed to the general school operation rather than to specific subjects or functions
3. It attacks fundamental problems of broad financial needs of our schools
4. It involves a long-range commitment on the part of the Federal Government
5. It requires Federal appropriations of considerable size

The transition from Federal <u>aid</u> to Federal <u>support</u> will establish a need for the development of a rational and systematic method for distributing Federal resources to the states--and will thereby provide

the rationale for a large-scale study of the development of Federal allocation models. This paper has described a simple, basic model which could be a prototype of a larger, more complicated model to achieve this end.

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